Case study title: **Integrating Vulnerability Assessments with Development Planning Efforts in the Caribbean**

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Case study emphasis: Integrated hazard assessment, mitigation planning, sustainable development planning

Summary:

Offers a GIS-driven risk-based methodology that enables communities and island nations in the Caribbean to develop land use plans built upon a foundation of disaster resilience and sustainable development. The damage potential (expressed in terms of economic loss to a typical housing type) was quantified for each hazard for a consistent return period (100 years). A composite hazard map was prepared that integrates the damage potential for each hazard simultaneously to show the intensity or levels of composite hazard throughout the island. This methodology allows a consistent framework to: delineate areas at risk and define possible consequences; target development in areas less susceptible to natural hazards; provide a basis to support planning decisions that will reduce the impact of natural hazards on people and property; and, provide a framework for conducting vulnerability assessments.

A land use suitability analysis was linked to the risk assessment to identify future growth areas, areas where new development should be discouraged, and areas where specific engineering design or Best Management Practices (BMPs) should be implemented. The hazard assessment methodology was designed to evaluate individual and composite natural hazards throughout the island, in addition to allowing the 78 municipalities in Puerto Rico to download hazard information for their own community. The study included a capability assessment that evaluated existing laws, regulations and policies related to land development and the ability of Puerto Rico agencies to implement a range of hazard mitigation actions. A mitigation planning guide for local jurisdictions was prepared to facilitate the development of community-level hazard mitigation plans. A website was created to enable State agencies and local jurisdictions to have access to hazard maps and guidance documents that could be understood by a non-technical audience.

This study effort will provide the framework for Puerto Rico's Commonwealth Hazard Mitigation Plan.

The Integrated Hazard Assessment has become an important tool for administrative and regulatory agencies in Puerto Rico. It:

- Strengthens state-level hazard mitigation planning and creates a strong mechanism to encourage local-level hazard mitigation planning;
- Provides information useful for the development of a comprehensive mitigation strategy;
- Enhances planning and development decisions in rural municipalities by providing information to introduce natural risk reduction measures into community long-range development programs or plans;
- Provides a valuable tool to Central Government agencies to facilitate sound decision-making when reviewing major development projects throughout the Island;
- Develops a hazard information database that provides the foundation for a state-wide risk and vulnerability assessment.

Date that model application was completed: April 2002

Case study geographical location: Puerto Rico

Vulnerability assessment indicators:
Hurricane-strength winds, storm surge, flood, rainfall-induced landslides, seismic hazard indicators including ground shaking and liquefaction; and associated damage functions for specified land uses and reoccurrence intervals.

Methodology data requirements:
individual hazard profiles, intensity/frequency relationships, susceptibility maps that differentiates variations in hazard intensity due to local conditions, damage functions for each hazard, damage potential (expressed in terms of potential property loss) related to each hazard (expressed as a percentage of building replacement value),GIS application to cumulatively combine the damage potential for the individual hazards to develop a composite hazard ranking.

Direct participants in the application of the model of the vulnerability assessment:
Local and National Governments

Economic and social sector participants directly involved:
Community Associations, key industrial/commercial stakeholders in the community.

Methodology objective:
To create a composite hazard assessment for the Island of Puerto Rico that encourages local hazard mitigation planning and promotes sustainable development planning.

Methodology output:
Individual hazard maps and composite hazard map for the Island of Puerto Rico and its 78 municipalities; hazard mitigation plans; integrating hazard mitigation elements into comprehensive land use plans.

Results of methodology application at case study site:
The Integrated Hazard Assessment for Puerto Rico will provide the framework for the development of a Commonwealth Hazard Mitigation Plan and associated municipal-level hazard mitigation plans that are compliant with the U.S. Federal Emergency Management Agency (FEMA) recently enacted Disaster Mitigation Act of 2000.

Lessons learned:
Difficulties inherent in applying consistent vulnerability assessment tools for large urban areas, medium-sized cities, and low-density, rural communities with limited capabilities. Need for simplified loss estimation tools for addressing critical infrastructure, lifelines, and other important public and private sector facilities located in hazard-prone areas. Trade-offs between the use of annualized damages (standard approach for benefit/cost analyhsis) and the use of single point estimates (using a uniform re-occurrence interval that would apply to disparate natural hazards). Application of several GIS-driven hazard assessment and vulnerability assessment methodologies and their value (and associated costs) in developing comprehensive land-use plans that are built around the framework of disaster resilience and sustainable development planning concepts.